Tech brief for Differential Vertical Wind Turbine and Vertical Parallel Propeller

A differential vertical wind turbine（Fig.1）comprises a rotatable rotor (102）mounted on a stationary shaft (101) with plural rotatably blade assemblies（200）mounted on the rotor. Each blade assembly has a planetary gear (201) secured to the top of the blade (202). A sun gear (104) is mounted on the stationary shaft to interface with planetary gears of the blade assemblies. The sun gear has the same diameter as the planetary gears but with half circumference of its teeth removed, the smooth surface of the sun gear is not able to engage with the planetary gear at the teeth removed circumference and the blade assemblies are able to rotate freely. The blade has its center of pressure located at the tail section, during blade movement the tail section will be forced by the wind pressure to align with the wind direction and the blade generates minimum drag。

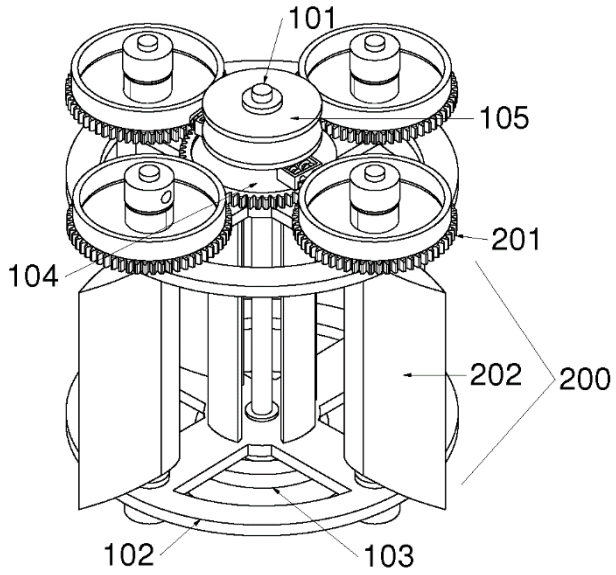

Fig. 1

When a planetary gear revolves counter-clockwise around the teeth remaining circumference of the sun gear (Fig. 2), the sun gear then engages with the planetary gear and the blade assembly starts to rotate counter-clockwise. Since both gears have the same diameters, the planetary gear rotates twice the angle that it revolves the sun gear. The rotation of the planetary gear drives the blade to increase its angle of attack towards the incident wind. Fig. 2 is an animation diagram presenting a

blade assembly revolving around the sun gear. When a planetary gear revolves counter-clockwise around the sun gear from 0° to 30°, because of the teeth engagement, the planetary gear also self-rotates 30° counter-clockwise, the blade totally rotates 60° at 30° reference point. Following this analysis, the blade will have 90° angle of attack toward incident wind nearby 90° reference point and the blade will fully extend its center of pressure outreach to the peripheral of the turbine. Pulley (105) is used to rotate the sun gear to direct toward the wind direction and pulley (103) is the output pulley used to drive the generator.

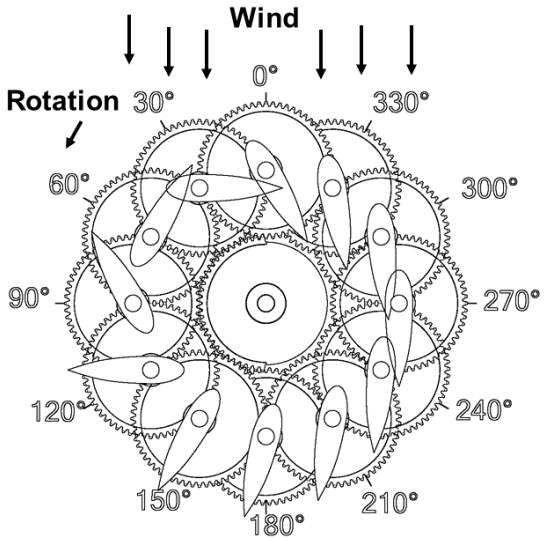

Fig. 2

The design goal of a differential vertical wind turbine is to **optimize the pressure difference** between the downwind blades and the upwind blades, therefore to **optimize the output**.

A vertical parallel propeller (Fig. 3) has similar principle as the differential vertical wind turbine except the blade assemblies and the driving shaft are different. It uses external power to drive the shaft (301) and the rotor (302). There are plural rotatable blade assemblies (400） mounted on the rotor, each blade assembly has a planetary gear (401) secured to the axis of a transmitter gear (403) and the transmitter gear engages to a receiver gear (404) with equal diameter. The receiver gear then secures to a blade (405). A rotatable sun gear (304) is mounted on the shaft to interface with planetary gears of the blade assemblies. The sun gear has the same diameter as the planetary gears but with ¾ circumference of its teeth removed, the smooth surface of the sun gear is not able to engage with the

planetary gear at the teeth removed circumference and the blade assemblies are able to rotate freely. The blade has its center of hydro pressure located at the tail section, during blade movement the tail section will be forced by hydro pressure to align with the fluid stream and generates minimum drag.

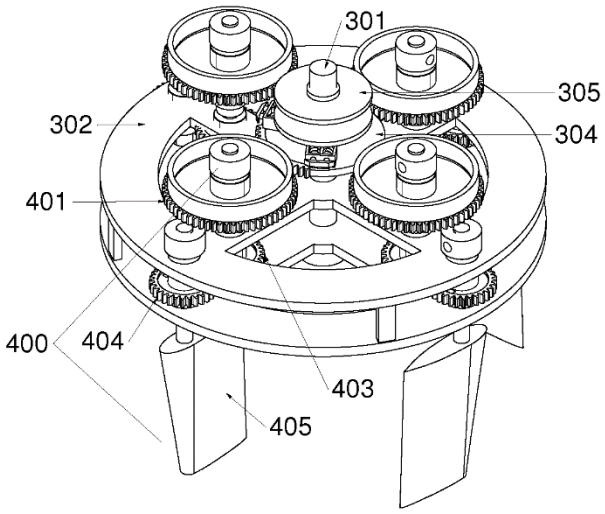

Fig. 3

When a planetary gear revolves counter-clockwise around the teeth remaining circumference of the sun gear (Fig. 4), the sun gear then engages with the planetary gear and drives it to rotate counter-clockwise but the blade rotates clockwise, because of the reverse gear set (403) and (404). Since both reverse gears have the same diameters, the net rotation of the blade is nulled. Fig. 4 is an animation diagram presenting a blade assembly revolving around the sun gear. When a planetary gear revolves counter-clockwise around the sun gear from 0° to 30°, because of the teeth engagement and the cancelation of the reverse gear set, the net rotation of the blade is 0° at 30° reference point. Following this analysis, the blade maintains 0° rotation during the revolution from 0° to 90° reference. Pulley (305) is used to rotate the sun gear to direct to the course of the vessel.

The design goal of the vertical parallel propeller is to **minimize the rotational component** of the propelling, therefore to **minimize the turbulence** and **reduce energy inefficiency**.

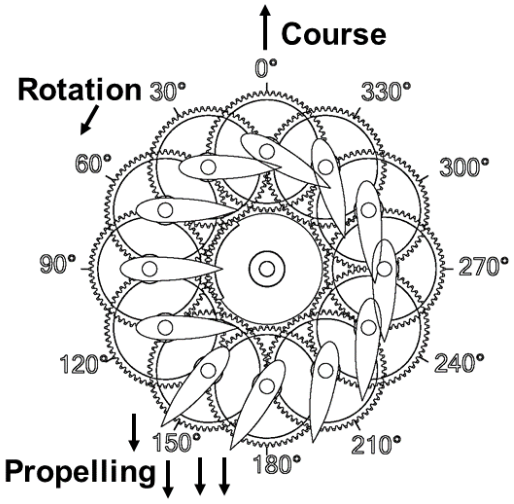

Fig. 4

The combination of differential vertical wind turbine and vertical parallel propeller forms into a “wind transformer” concept. It converts low density, alternate direction wind into useful condensed energy to empower vessels. Both differential vertical wind turbine and vertical parallel propeller are 360° operatable. The wind transformer eliminates the complicated operation of a traditional sail and increases mobility in all directions of vessels (ref. Voith Schneider propeller). Integration of a motor, batteries and Diesel engine (for emergency only) with the wind transformer, a hybrid power system may reinvent a new era of wind powered navigation (Fig. 5).

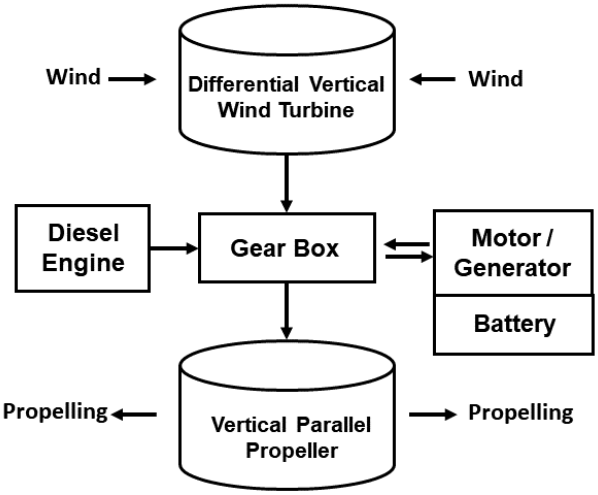

Fig. 5: A 360° wind, Diesel, electric hybrid power system